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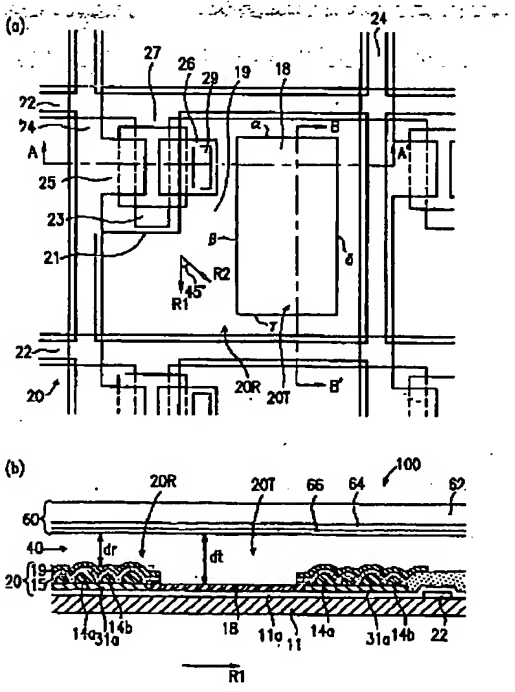
(54)【発明の名称】　液晶表示装置

(57)【要約】
【課題】　ラビング筋が目立たない、表示品位に優れた液晶表示装置を提供する。
【解決手段】　第１基板と第２基板との間に挟持された誘電率異方性が負の液晶材料からなる液晶層を有し、それぞれの基板の液晶層側の表面に垂直配向膜が形成されており、且つ、ラビング処理に対する段差が少ない方の基板の垂直配向膜のみがラビング処理が施されている。



【特許請求の範囲】
【請求項１】　第１及び第２基板と、該第１基板と第２基板との間に挟持された誘電率異方性が負の液晶材料からなる液晶層を有し、
該第１及び第２基板は、それぞれの該液晶層側の表面に第１及び第２垂直配向膜を有し、該第１垂直配向膜のみにラビング処理が施されており、
該第１基板は該第２基板よりもラビング処理に対する段差が少ない、液晶表示装置。
【請求項２】　前記第１基板はさらにカラーフィルタ層を有し、
前記第２基板は、複数の絵素領域毎に、スイッチング素子と、該スイッチング素子に接続された絵素電極とを有する、請求項１に記載の液晶表示装置。
【請求項３】　第１及び第２基板と、該第１基板と第２基板との間に挟持された誘電率異方性が負の液晶材料からなる液晶層を有し、
該第１及び第２基板は、それぞれの該液晶層側の表面に第１及び第２垂直配向膜を有する液晶表示装置であって、
前記第２基板は、絵素領域毎に、反射電極領域と透過電極領域とを有し、該反射電極領域は該透過電極領域よりも高く、該第２基板の表面に段差を形成しており、該第２垂直配向膜は、ラビング処理に対する段差が最小となる方向にラビングされており、且つ、該第１垂直配向膜はラビング処理されていない、液晶表示装置。
【請求項４】　前記反射電極領域と前記透過電極領域とによって前記第２基板の表面に形成される段差は、前記ラビング方向に対しては存在しない、請求項３に記載の液晶表示装置。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、液晶表示装置に関し、特に、屋外のような明るい場所や、外光の少ない屋内や暗がりでも優れた視認性を有する透過反射両用型の液晶表示装置に関する。
【０００２】
【従来の技術】液晶表示装置は、薄型で低消費電力であるという特徴を生かして、ワードプロセッサやパーソナルコンピューターなどのＯＡ機器や、電子手帳等の携帯情報機器、あるいは、液晶モニターを備えたカメラ一体型ＶＴＲ等に広く用いられている。これら液晶表示装置の多くには、誘電異方性が正の液晶材料を基板に対し水平に配向させ、かつ上下の基板間で液晶分子が９０度にねじれた配向状態をとるＴＮ（ツイステッドネマティック）モードが用いられている。また、ＴＮモードに比べて高いコントラストが実現できるため、誘電率異方性が負の液晶材料を基板に対して垂直に配向させたＤＡＰ（ディフォーメーションアラインドフェイズ）モードの開発が盛んに行われている。
【０００３】
【発明が解決しようとする課題】しかしながら、ＤＡＰモードはＴＮモードに比べて、電圧を印加した際に、液晶分子の配向方向を規定するための配向膜の表面を布でこする処理（以下ラビング処理と称す）を行った方向に筋状の輝度ムラ（以下ラビング筋と称す）が発生しやすく、表示品位が低下するという問題があった。
【０００４】特に、ＤＡＰモードを用いた透過反射両用型の液晶表示装置（本願出願人による特願平9-201176号）においては、従来のＤＡＰモードを用いた透過型液晶表示装置と比べて、ラビング筋が著しく目立つという問題があった。
【０００５】本発明は、上記課題を解決するためになされたものであり、ラビング筋が目だ立たない、表示品位に優れた液晶表示装置を提供することを目的とする。
【０００６】
【課題を解決するための手段】本発明の液晶表示装置は、第１及び第２基板と、該第１基板と第２基板との間に挟持された誘電率異方性が負の液晶材料からなる液晶層を有し、該第１及び第２基板は、それぞれの該液晶層側の表面に第１及び第２垂直配向膜を有し、該第１垂直配向膜のみにラビング処理が施されており、該第１基板は該第２基板よりもラビング処理に対する段差が少ない構成を有し、そのことによって上記目的が達成される。
【０００７】前記第１基板はさらにカラーフィルタ層を有し、前記第２基板は、複数の絵素領域毎に、スイッチング素子と、該スイッチング素子に接続された絵素電極とを有する構成としてもよい。
【０００８】本発明の液晶表示装置は、第１及び第２基板と、該第１基板と第２基板との間に挟持された誘電率異方性が負の液晶材料からなる液晶層を有し、該第１及び第２基板は、それぞれの該液晶層側の表面に第１及び第２垂直配向膜を有する液晶表示装置であって、前記第２基板は、絵素領域毎に、反射電極領域と透過電極領域とを有し、該反射電極領域は該透過電極領域よりも高く、該第２基板の表面に段差を形成しており、該第２垂直配向膜は、ラビング処理に対する段差が最小となる方向にラビングされており、且つ、該第１垂直配向膜はラビング処理されていない、構成を有し、上記目的が達成される。
【０００９】前記反射電極領域と前記透過電極領域とによって前記第２基板の表面に形成される段差は、前記ラビング方向に対しては存在しない構成とすることが好ましい。
【００１０】以下、作用について説明する。
【００１１】本発明の液晶表示装置においては、ラビング処理が段差によって乱れることを最小にすることができるので、ラビング処理の不均一さに起因する表示不良（ラビング筋）を低減することができる。特に、垂直配向膜と負の誘電異方性を有する液晶材料を用いる透過反

射両用型の液晶表示装置に適用することによって、優れた表示品質を実現することができる。また、ラビング方向に対する段差が絵素領域内に存在しない構成とすることによって更に表示品質を向上することができる。

【００１２】

【発明の実施の形態】以下、透過反射両用型の液晶表示装置を例に本発明の実施形態を説明する。透過反射両用型の液晶表示装置は、液晶パネル背面に設けられたバックライトからの透過光を利用して表示する透過型液晶表示装置の機能と、液晶パネル前面の周囲光を利用して表示する反射型液晶表示装置の機能を兼ね備えた液晶表示装置である（例えば、本願出願人による特願平9-201176号）。本発明は、以下に詳述するように、大きな段差を有する表面に形成された垂直配向膜と負の誘電異方性を有する液晶材料を用いる液晶表示装置において効果が大きいが、段差が小さい場合にも効果があり、下記の実施形態に限られない。

【００１３】以下、本発明の実施形態を図面を参照しながら説明する。

【００１４】（実施形態１）図１は、本発明の実施形態１における透過反射両用型液晶表示装置１００を示す。図１（ａ）は液晶表示装置１００を構成するアクティブマトリックス基板２０を示した平面図であり、図１（ｂ）は液晶表示装置１００の部分断面図を示し、図１（ａ）のＢ－Ｂ’線に沿った断面に対応する。なお、図１（ａ）のＡ－Ａ’線に沿った断面図は、製造工程を示す図４（ｂ）に示す。

【００１５】図１（ｂ）に示したように、液晶表示装置１００は、アクティブマトリクス基板２０と対向基板（カラーフィルタ基板）６０と、これらの間に挟持された液晶層４０とを有している。液晶表示装置１００の最小の表示の単位となる絵素は、反射電極１９によって規定される反射領域と透明電極１８によって規定される透過領域とを有する。液晶層４０の厚さは、反射領域においてはｄｒであり、透過領域ではｄｔ（ｄｔ≒２ｄｒ）となっている。これは、表示に寄与する光（反射領域の反射光と透過領域の透過光）の光路長をほぼ等しくするためである。ｄｔ＝２ｄｒが好ましいが、表示特性との関係で適宜設定すればよい。少なくとも、ｄｔ＞ｄｒであればよい。典型的には、ｄｔは約４～６μｍで、ｄｒは約２～３μｍである。すなわち、アクティブマトリクス基板２０の絵素領域内に、約２～３μｍの段差が形成されている。なお、反射電極１９が図示したように凹凸を有している場合には、平均値をｄｒとすればよい。

【００１６】このように、透過反射両用型液晶表示装置１００においては、液晶層４０の厚さの異なる領域（反射領域と透過領域）が形成される。この例では、アクティブマトリクス基板２０の液晶側表面に、高さの異なる反射電極領域２０Ｒと透過電極領域２０Ｔとを有する。両基板２０及び６０の液晶層４０側表面には、垂直配向膜（不図示）が形成されている。本実施形態では、アクティブマトリクス基板２０上の垂直配向膜に、図１中矢印Ｒ１で示した方向にラビング処理を施した。例えば、垂直配向膜ＪＡＬＳ２００４（日本合成ゴム製）を膜厚が８０ｎｍとなるように印刷し、１８０℃で２時間焼成した。このアクティブマトリクス基板６０にレーヨン製の布を用いてローラー回転数１００ｒｐｍ、基板の送り速度１０００ｍｍ／ｍｉｎでラビング処理を行った。

【００１７】通常の液晶表示装置におけるラビング方向は、図１（ａ）の矢印Ｒ２で示した方向（ゲートバスライン２２やソースバスライン２４に対して４５°の角度である。しかしながら、Ｒ２の方向にラビング処理を行うと、ラビング筋の発生が多く、表示品位の低い液晶表示装置しか得られなかったのに対し、Ｒ１の方向にラビング処理を行った場合、ラビング筋の発生が少なく、配向状態が良好で、優れた表示品質の液晶表示装置１００が得られた。

【００１８】これはＲ１の方向にラビングした場合、ラビング方向に対してラビング布の毛足が直接当たる段差は、図１（ａ）中の透過領域２０Ｔの四辺の内の辺αとβのみであるが、Ｒ２の方向にラビングした場合はラビング布の毛足が辺α、β、γ、δの段差に当たることになり、Ｒ１方向にラビングした場合に比べて、ラビング布に当たる段差がより多い（段差の辺が長い）。その結果、ラビング布の毛足が乱れることになり、均一なラビング処理が困難となり、結果としてラビング筋などの不良の発生原因となる。従って、透過部の形状の長手方向に平行なＲ１方向にラビングすることで、段差によるプレティルト角のばらつきを最小限に押さえることが出来る。

【００１９】液晶分子の配向は、基板上に形成された配向膜の規制力と、液晶分子間の相互作用によって決定される。誘電異方性が負の液晶材料の場合、電圧を印加することにより、液晶分子は垂直配向状態から水平配向状態に再配向するが、再配向する方向、つまり、液晶分子が倒れる方向は基板内で一様である必要がある。もし液晶分子が倒れる方向がばらばらであると、配向欠陥（以下ディスクリネーション）が発生し、表示品位を劣化させる。液晶分子が一様に同じ方向に倒れるようにするために、ラビング処理を行う。この時、液晶分子は基板法線方向からラビング処理を行う方向に少し傾いた状態に配向する（以下この傾き角度をプレティルト角と称する）。ラビングのメカニズムについては、配向膜を構成する高分子の側鎖がラビング方向に配列し、液晶分子が側鎖に沿って配向するというモデルが一般に考えられている。しかしながら、垂直配向膜に用いられている側鎖は、炭素数が３～２０個という長鎖アルキル鎖であることが多く、その方向を１方向に安定して揃えることは容易ではない。配向膜の下地すなわち基板の表面が平坦であれば、ラビングの効果も一様であるが、段差があれば

ラビングの効果が場所により異なる結果、プレティルト角が一様にならず、ラビング筋となって見えると考えられる。従って、特に、垂直配向膜と誘電率異方性が負の液晶材料を用いた場合に、ラビング処理に対する段差が多いと、配向不良の発生が発生しやすい。

【００２０】本明細書でいう「ラビング処理に対する段差」とは、絵素領域内において、ラビング方向と平行でない辺を有する段差（不連続な）を指し、その辺の長さの合計で段差の量を評価する。絵素領域以外の段差は、表示に影響しないので考慮する必要はない。また、段差の高さの違いが、約１μｍ未満であると、ラビング処理に対して実質的に影響がないので、高さの違いが約１μｍ以上の段差のみ考慮すればよい。

【００２１】以下に、本発明の液晶表示装置１００の構成およびその製造方法を説明する。この透過反射両用型のアクティブマトリクス基板２０は、絶縁基板であるガラス基板１１の上に、走査線としての複数のゲートバスライン２２および信号線としてのソースバスライン２４が交互に交差して設けられている。各ゲートバスライン２２および各ソースバスライン２４によって囲まれた矩形状の領域内には、光反射効率の高い材料からなる反射電極１９と、それとは別に、光透過効率の高い材料からなる透明電極１８とが配置されており、これら反射電極１９と透明電極１８とで絵素電極を形成している。

【００２２】この各絵素電極が配置された領域内の隅部には、ゲートバスライン２２から絵素電極に向かって延設されたゲート電極２３が分岐されており、このゲート電極２３の先端部分にスイッチング素子として薄膜トランジスタ（ＴＦＴ）２１が形成されている。上記ゲート電極２３はＴＦＴ２１の一部を構成する。ＴＦＴ２１は、図４（ｂ）に示すように、ガラス基板１１の上に形成された上記ゲート電極２３の上方に配設されている。ゲート電極２３は、ゲート絶縁膜１１ａによって覆われており、ゲート絶縁膜１１ａの上には、ゲート電極２３の上方を覆うように半導体層２７が積層されている。

【００２３】この半導体層２７上の両端部を覆って一対のコンタクト層２８、２８が形成されている。

【００２４】ソースバスライン２４はソース電極２５に電気的に接続されており、コンタクト層２８上に形成されたソース電極２５の先端部がゲート電極２３の上に絶縁状態で重畳されて、各ＴＦＴ２１の一部を構成する。ゲート電極２３の上には、ソース電極２５とは間隔を空け、かつ、ゲート電極２３とは絶縁状態で重畳してＴＦＴ２１のドレイン電極２６がコンタクト層２８上に設けられている。そして、このドレイン電極２６は下地電極３１ａを介して絵素電極に電気的に接続されている。

【００２５】このとき、下地電極３１ａと次段のゲートバスライン２４とが、ゲート絶縁膜１１ａを介して重なるような構造とすることにより補助容量を形成している。また、この下地電極３１ａを後述する凹凸部が存在するほぼ全領域に形成することにより、プロセスの影響を均一にすることが可能となる。

【００２６】一方、上述した光反射効率の高い材料からなる反射電極１９の下には、ガラス基板１１の上にランダムに形成した高さの高い凸部１４ａおよび高さの低い凸部１４ｂと、これら凸部１４ａおよび１４ｂの上に形成された高分子樹脂膜１５とが存在する。

【００２７】この高分子樹脂膜１５の上表面は、上述した凸部１４ａおよび１４ｂの存在により、連続する波状となっている。

【００２８】上述した凸部１４ａおよび１４ｂの上に存在し、上表面が連続する波状となっている高分子樹脂膜１５部分の上には、上述した反射電極１９が形成されており、この反射電極１９は、光反射効率の高い、例えばＡｌにより形成されている。なお、反射電極１９はコンタクトホール２９を介してドレイン電極２６と電気的に接続されている。

【００２９】また、本発明の透過反射両用型の液晶表示装置においては、反射電極１９とは別に透明電極１８が形成されており、この透明電極１８は光透過効率の高い材料、例えばＩＴＯ（Ｉｎｄｉｕｍ　Ｔｉｎ　Ｏｘｉｄｅ）などにより形成されている。次に、この透過反射両用型のアクテイブマトリクス基板２０の要部である反射電極１９および透明電極１８の形成方法を図面に基づいて説明する。図２（ａ）（ｂ）、図３（ａ）（ｂ）、図４（ａ）（ｂ）は、図１に示す液晶表示装置のＡ－Ａ線部分におけるプロセス断面図である。

【００３０】まず、図２（ａ）に示すように、ガラス基板１１上には、Ｃｒ、Ｔａなどからなる複数のゲートバスライン２２（図１参照）と、このゲートバスライン２２から分岐したゲート電極２３とが形成されている。

【００３１】そして、これらゲートバスライン２２およびゲート電極２３を覆って、ガラス基板１１上の全面に、ＳｉＮｘ，ＳｉＯｘなどからなるゲート絶縁膜１１ａが形成されており、ゲート電極２３の上方のゲート絶縁膜１１ａ上には、非晶質シリコン（ａ－Ｓｉ）や多結晶シリコン、ＣｄＳｅなどからなる半導体層２７が形成されている。そして、この半導体層２７の両端部には、非晶質シリコン（ａ－Ｓｉ）などからなるコンタクト層２８、２８が形成されている。

【００３２】このコンタクト層２８、２８のうちの一方側上には、Ｔｉ、Ｍｏ、Ａｌなどからなるソース電極２５が重畳形成されており、また他方側上には、ソース電極２５と同様に、Ｔｉ、Ｍｏ、Ａｌなどからなるドレイン電極２６が重畳形成されている。

【００３３】なお、本実施形態１では、ガラス基板１１としては、例えばコーニング社製の＃７０５９の厚さ１．１ｍｍのものを用いた。

【００３４】そして、図２（ｂ）に示すように、ソースバスライン２４を構成する金属層３１と、この金属層３

1を用いて、この金属層31の形成と同時に下地電極31aをスパッタ法によって形成した。

【0035】続いて、図3（a）に示すように、ソースバスライン24を構成するITO層30をスパッタ法によってパターニングした。

【0036】本実施形態1においては、ソースバスライン24を構成する層を金属層31とITO層30との2層構造とした。この構造には、仮にソースライン24を構成する金属層31の一部に膜の欠陥があったとしても、ITO層30によって電気的に接続されるためソースバスライン24の断線を少なくすることができるという利点がある。

【0037】このITO層30を用いて、このITO層30の形成と同時に絵素電極を構成する透明電極18を形成した。このようにすることで、透明電極18をソースバスライン24の形成時に同時に作り込むことができ、層数増加を招くことがなくなる。

【0038】次に、図3（b）に示すように、感光性樹脂のレジスト膜12からなる角落としされた断面略円形状の凸部14aおよび14bを反射電極19がパターニングされる領域の下に形成する。

【0039】ここで、この反射部領域に形成された凸部14aおよび14bの形成プロセスについて、図5（a）～（d）を用いて簡単に説明する。

【0040】まず、図5（a）に示すように、ガラス基板11（実際は、図3（b）に示すように、ガラス基板11上には、金属層31と下地電極31aとが既に形成されている。）の上に、感光性樹脂からなるレジスト膜12をスピンコート方式により形成する。なお、レジスト膜12としては、後述する高分子樹脂膜15と同一の材料であるOFPR－800の感光性樹脂を、好ましくは500rpmから3000rpm、本実施形態1では1500rpmで30秒スピンコートし、レジスト膜12の厚さを2．5μmとした。

【0041】次に、このレジスト膜12が形成されたガラス基板11を、例えば90℃で30分間プリベークする。

【0042】続いて、図6に示すような、例えば板体13cに2種類の円形のパターン孔13a、13bが形成されているフォトマスク13を使用し、このフォトマスク13を、図5（b）に示すようにレジスト膜12の上方に配置して、このフォトマスク13の上方から図の矢印で示すように露光する。

【0043】なお、本実施形態1におけるフォトマスク13は、直径5μmの円形をしたパターン孔13aと、直径3μmの円形をしたパターン孔13bとがランダムに配置されており、相互に近接するパターン孔の間隔は、少なくとも2μm以上隔離されている。ただし、あまり隔離し過ぎると、高分子樹脂膜15の上表面が連続する波状となり難い。

【0044】次に、例えば東京応化製のNMD－3からなる濃度2．38%の現像液を使用して現像を行う、これにより、図5（c）に示すように、ガラス基板11の一方の反射部領域表面に、高さの異なる微細な凸部14a'、14b'が多数個形成される。これら凸部14a'、14b'は上縁が角張っている本実施形態1では、直径5μmのパターン孔13aによって高さ2．48μmの凸部14aが形成され、直径3μmのパターン孔13bによって高さ1．64μmの凸部14bが形成された。

【0045】これらの凸部14a'、14b'の高さは、パターン孔13a、13bの大きさ、露光時間、現像時間によって変化させることが可能であり、パターン孔13a，13bの大きさとしても、上述のサイズに限定されるものではない。

【0046】次に、図5（d）に示すように、凸部14a'、14b'を形成したガラス基板11を200℃で1時間加熱して熱処理を行う。これによって、図5（c）に示したように上端部に角部を有する現像されたままの凸部14a'、14b'を軟化させて、角部が丸くなった、つまり角落としされた断面略円形状の凸部14a，14bを形成する。

【0047】図3（b）に示したような凸部14a，14bは、上述したような工程により形成される。次に、図4（a）に示すように、高分子樹脂膜をガラス基板11上にスピンコートしてパターンニングし、高分子樹脂膜15を形成した。高分子絶縁膜としては、上述したOFPR－800を使用し、好ましくは1000rpm～3000rpmでスピンコートする、本実施形態1では、2000rpmでスピンコートした。

【0048】これにより、上表面が連続する波状をした高分子樹脂膜15が形成されることになる。

【0049】次に、図4（b）に示すように、上述した高分子樹脂膜15の上の所定箇所にAlからなる反射電極19を、例えばスパッタリングすることにより形成した。反射電極19に使用するのに適した材料としては、AlやAl合金の他に、例えば光反射効率の高いTa、Ni、Cr、Agなどを挙げることができ、反射電極19の厚さとしては、0．01～1．0μm程度が適している。このようにして形成された光反射効率の高い材料からなる反射電極19は、下地膜と同様に上表面が連続する波状となる。

【0050】本実施形態1においては、透明電極18をソースバスライン24の形成と同時に形成しているが、ソースバスライン24が金属層31とITO層30との2層構造ではなく、金属層31の単層である場合には、透明電極18の形成とソースバスライン24の形成とは、別々であってもよい。

【0051】なお、フォトマスク13のパターン孔13a、13bの形状は、本実施形態1では円形としている

を、（ｂ）は（ａ）のＦ－Ｆ’線に沿った断面図を示す。図１０（ａ）に示したように、アクティブマトリクス基板８０を上方から観察すると、絵素内中央部に透過電極領域８０Ｔが四角形に設けられ、それを囲うように反射電極領域８０Ｒが設けられている。反射電極領域８０Ｒの外郭は、ゲート配線８２とソース配線８４の縁に沿った四角形となっている。この例では、反射電極領域８０Ｔにはゲート電極８３（及びゲート配線８２）と同一の材料によって形成された反射率の高い層（反射層）８９が設けられている。

【００６２】図１０（ｂ）に示したように、反射層８９はゲート絶縁膜９２で覆われており、その上に、絵素電極として機能する透明電極８８が形成されている。反射層８９と透明電極８８は絶縁されている。反射層８９と反射層８９上に形成された透明電極８８とが反射電極領域８０Ｒを形成する。

【００６３】アクティブマトリクス基板８０は、ガラス基板等の絶縁性基板８１上に反射性の材料からなる導電膜を堆積し、この導電膜をパターニングすることによりゲート電極８３、ゲート配線８２及び反射層８９を形成する。ゲート電極８３、ゲート配線８２及び反射層８９を覆うゲート絶縁膜９２を形成した後、半導体層９３、チャネル保護層９４、ソース・ドレイン電極となるｎ⁺－Ｓｉ層９５を順に、堆積、パターニングして、ＴＦＴ８１を形成する。ソース配線８４の一部となる金属層９７ｂと、ドレイン－絵素電極接続層９６とを同一プロセスにて形成する。接続層９６はＴＦＴ８１のドレイン電極９５に一部重畳し電気的に接続されている。透明導電材料（例えば、ＩＴＯ）をスパッタ法によって成膜し、パターニングして、透明電極８８及びソース配線８４の上層９７ａを形成する。透明電極８８は、各絵素内全域に形成し、絵素電極として機能する。透明電極８８は接続層９６に一部重畳することによりＴＦＴ８１のドレイン電極９５に電気的に接続されている。その後、少なくともＴＦＴ８１を覆うパシベーション膜９８が形成される。

【００６４】これらを覆う垂直配向膜（不図示）を形成し、上述したように、絵素領域内において、ラビング処理に対する段差が少ない方向（透過電極領域８０Ｔの長辺に平行）にラビング処理を施すことによって、ラビング筋の発生が少ないアクティブマトリクス基板が形成される。反射電極領域８０Ｒの高さは、例えば、反射層８９の厚さや、反射電極領域内にパシベーション膜９８を設けて調整することで制御することができる。

【００６５】

【発明の効果】以上詳述したように、本発明によると、ラビング処理による配向不良が発生せず、表示品質の優れた液晶表示装置が提供される。特に、垂直配向膜と負の誘電異方性を有する液晶材料を用いる透過反射両用型の液晶表示装置に適用することによって、優れた表示品質を実現することができる。

【図面の簡単な説明】

【図１】実施形態１における透過反射両用型液晶表示装置１００を示す。（ａ）は液晶表示装置１００を構成するアクティブマトリックス基板２０を示す平面図であり、（ｂ）は液晶表示装置１００の部分断面図である。

【図２】アクティブマトリックス基板２０の製造工程を説明する断面図である。

【図３】アクティブマトリックス基板２０の他の製造工程を説明する断面図である。

【図４】アクティブマトリックス基板２０の他の製造工程を説明する断面図である。

【図５】アクティブマトリックス基板２０の反射部領域に形成された凸部の形成方法を説明する断面図である。

【図６】反射部領域に凸部を形成するために用いれるフォトマスクを示す平面図である。

【図７】本発明の液晶表示装置に用いられる他のアクティブマトリックス基板を示す平面図であり、（ｂ）は（ａ）のＣ－Ｃ’線に沿った断面図である。

【図８】カラーフイルター基板６０の平面図である。

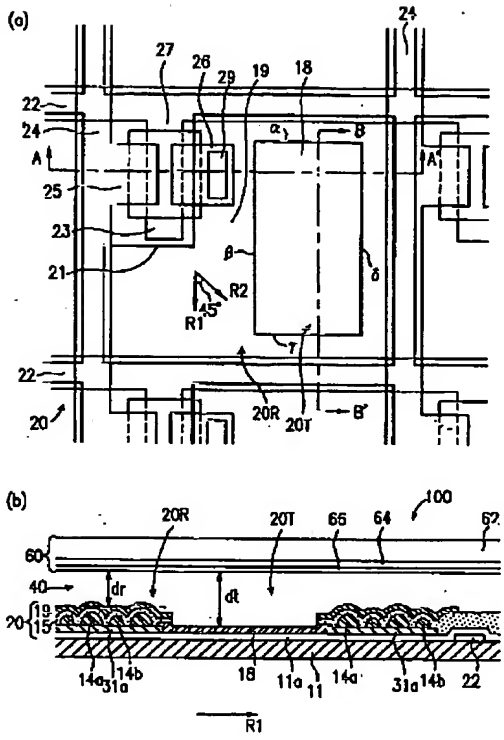
【図９】（ａ）は図８のＤ－Ｄ’線に沿った断面図であり、（ｂ）は図８のＥ－Ｅ’線に沿った断面図である。

【図１０】本発明の液晶表示装置に用いられる他のアクティブマトリックス基板を示す平面図であり、（ｂ）は（ａ）のＦ－Ｆ’線に沿った断面図である。

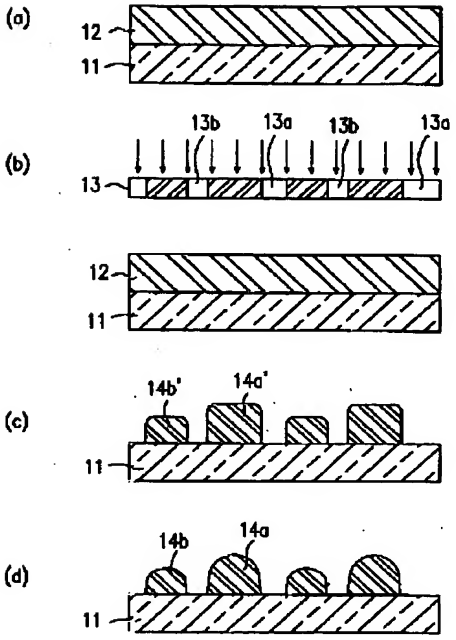
【符号の説明】

１８、６６　透明電極
１９　反射電極
２０　アクティブマトリクス基板
２０Ｒ　反射電極領域
２０Ｔ　透過電極領域
４０　液晶層
６０　対向基板（カラーフィルタ基板）
１００　液晶表示装置

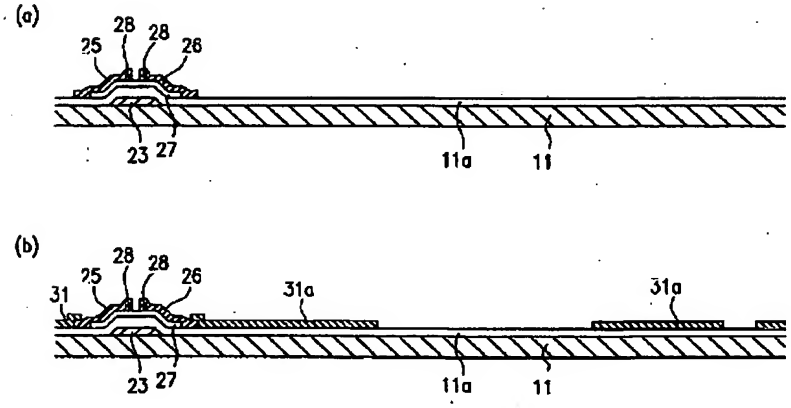
【図1】


(a)
24
27
26
29
19
18
22
24
A
25
23
21
α1
B
β
δ
R2
45°
R1
γ
22
20
20R
20T
B'
A'
(b)
100
20R
20T
65
64
62
60
40
dr
dt
20
19
15
14a
31a
14b
18
11a
11
14a
31a
14b
22
R1

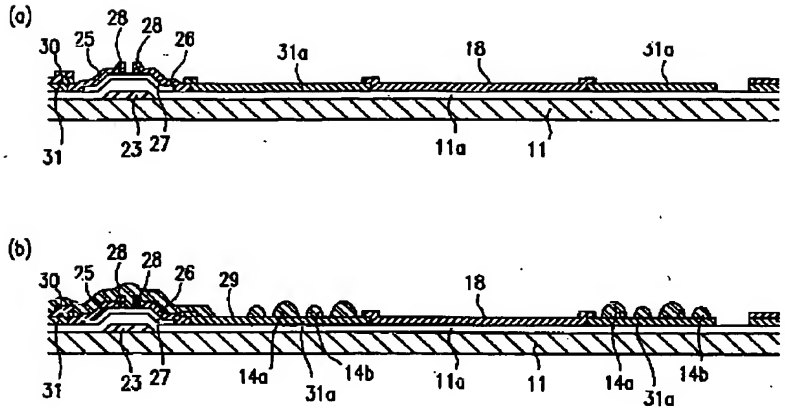
【図5】


(a)
12
11
(b)
13b
13a
13b
13a
13
12
11
(c)
14b'
14a'
11
(d)
14b
14a
11

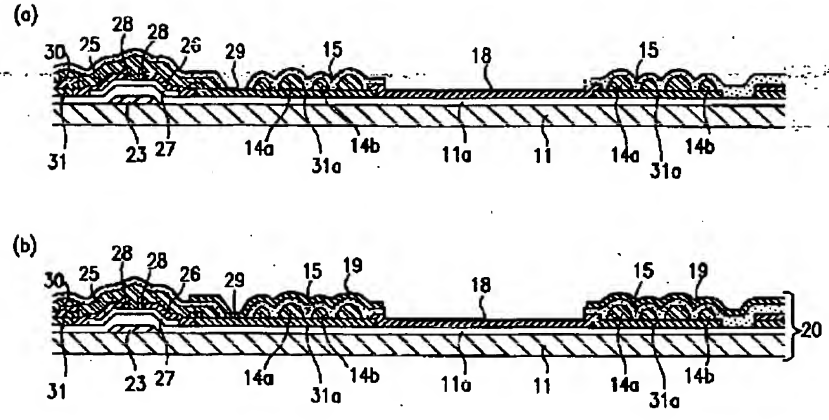
【図2】


(a)
25
28
28
26
23
27
11a
11
(b)
31
25
28
28
26
31a
31a
23
27
11a
11

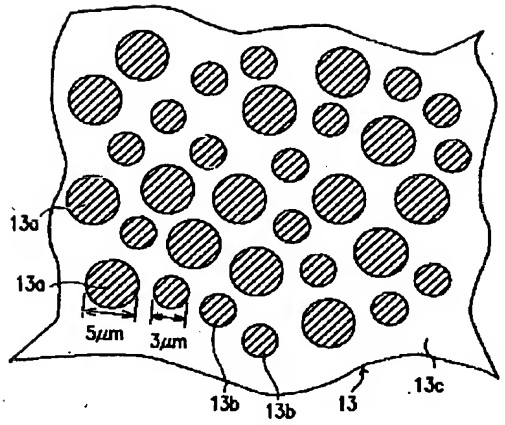
【図3】


(a)
30
25
28
28
26
31a
18
31a
31
23
27
11a
11
(b)
30
25
28
28
26
29
18
31
23
27
14a
31a
14b
11a
11
14a
31a
14b

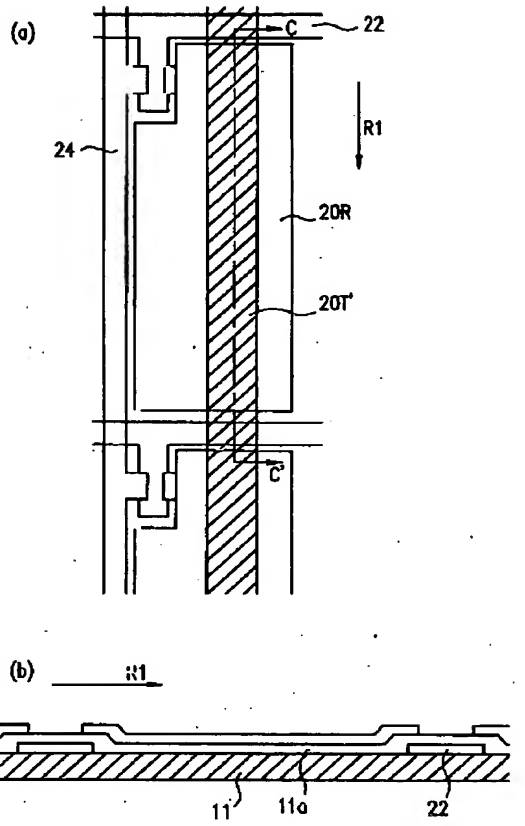
【図4】


(a)
30
25
28
28
26
29
15
18
15
31
23
27
14a
31a
14b
11a
11
14a
31a
14b
(b)
30
25
28
28
26
29
15
19
18
15
19
20
31
23
27
14a
31a
14b
11a
11
14a
31a
14b

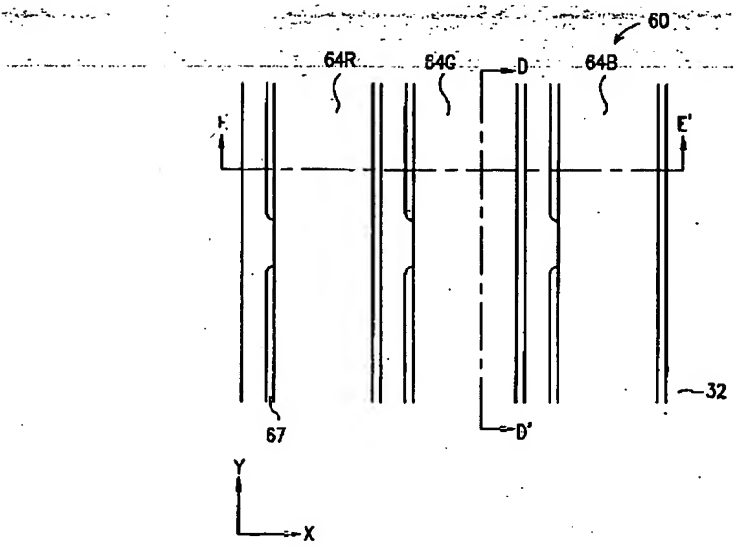
【図6】


13a
13a
5μm
3μm
13b
13b
13
13c

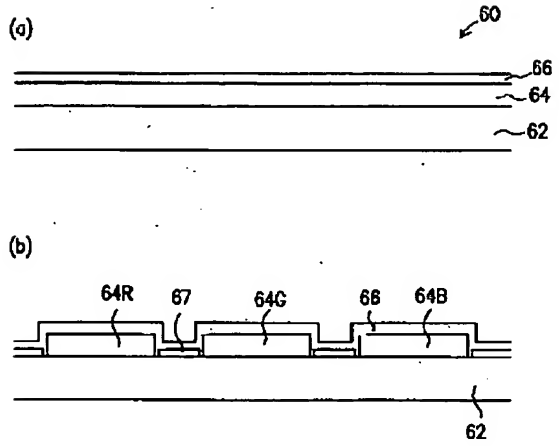
【図7】


(a)
C
22
R1
24
20R
20T'
C'
(b)
R1
11
11a
22

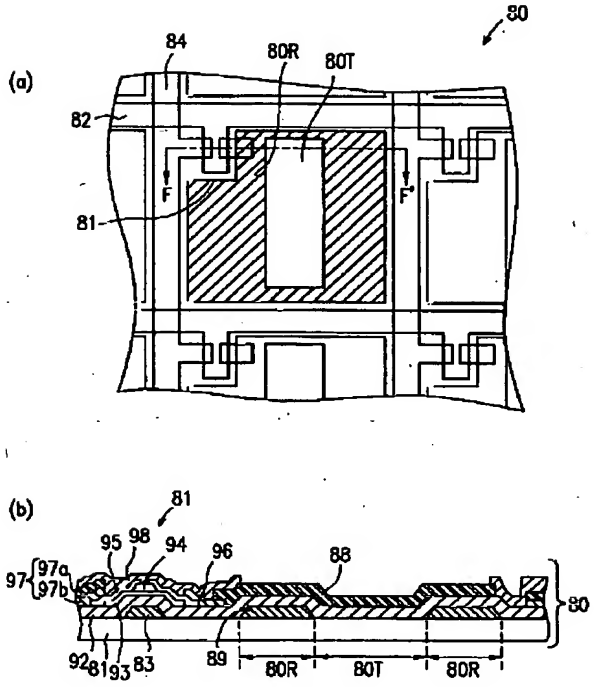
【図8】


60
64R
64G
D
64B
E
E'
32
67
D'
Y
X

【図9】



【図10】



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PATENT ABSTRACTS OF JAPAN

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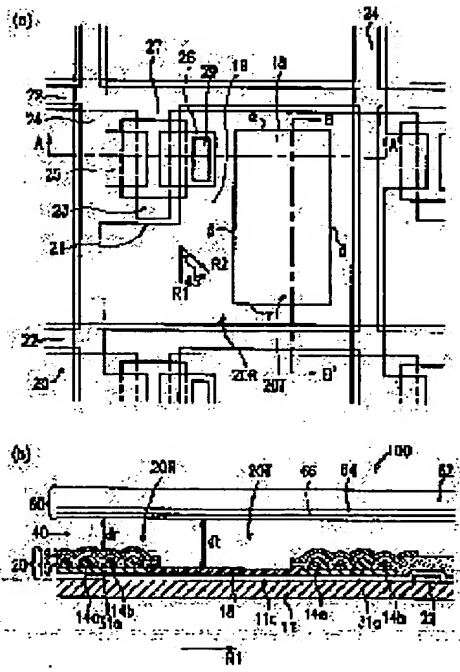
(54) LIQUID CRYSTAL DISPLAY DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To obtain excellent display quality without making rubbing lines conspicuous by subjecting only a first perpendicular alignment film to rubbing treatment and making a step formed on the first substrate by the rubbing treatment smaller than that on the second substrate.
SOLUTION: In this device, an active matrix substrate 20 is provided on its surface of the liquid crystal side with a reflective electrode region 20R and a transmissive electrode region 20T different in height and a perpendicular alignment layer is formed on each surface of the liquid crystal layer sides of the substrate 20 and another substrate 60, to perform rubbing treatment on these layers in an R1 direction different from a conventional R2 direction. When the rubbing treatment is performed in the R2 direction, many rubbing lines are caused to obtain only low display quality. On the other hand, when the rubbing treatment is performed in the R1 direction, fewer rubbing lines are caused, to attain a well-aligned state and to obtain excellent display quality. Also, by performing the rubbing treatment in the R1 direction parallel to the longitudinal direction of the shape of a transmission section, the variation in pretilt angle due to the difference in level can be controlled to the minimum.



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[Claim(s)]
[Claim 1] It has the liquid crystal layer which the dielectric constant anisotropy pinched between the 1st and 2nd substrates, and this 1st substrate and the 2nd substrate becomes from a negative liquid crystal ingredient. These 1st and 2nd substrates Level differences [as opposed to / in this 1st substrate / have the 1st and 2nd perpendicular orientation film on the front face by the side of this each liquid crystal layer, and rubbing processing is performed only to this 1st perpendicular orientation film, and / rubbing processing from this 2nd substrate] are few liquid crystal displays.
[Claim 2] It is the liquid crystal display according to claim 1 which has the picture element electrode by which said 2nd substrate was connected to the switching element and this switching element for two or more picture element fields of every by said 1st substrate having a light filter layer further.
[Claim 3] It has the liquid crystal layer which the dielectric constant anisotropy pinched between the 1st and 2nd substrates, and this 1st substrate and the 2nd substrate becomes from a negative liquid crystal ingredient. These 1st and 2nd substrates It is the liquid crystal display which has the 1st and 2nd perpendicular orientation film on the front face by the side of this each liquid crystal layer. Said 2nd substrate For every picture element field, it has a reflector field and a transparency electrode field, and this reflector field is higher than this transparency electrode field, and the level difference is formed in the front face of this 2nd substrate. This 2nd perpendicular orientation film It is the liquid crystal display with which rubbing is carried out in the direction in which the level difference to rubbing processing serves as min, and rubbing processing of this 1st perpendicular orientation film is not carried out.
[Claim 4] The level difference formed in the front face of said 2nd substrate of said reflector field and said transparency electrode field is a liquid crystal display according to claim 3 which does not exist to said direction of rubbing.

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the liquid crystal display of the mold both for transparency reflective which has the visibility which was excellent also in a bright location like the outdoors, indoor [with little outdoor daylight], or darkness especially about a liquid crystal display.
[0002]
[Description of the Prior Art] The liquid crystal display is widely used for the camcorder/movie equipped with OA equipment, such as a word processor and a personal computer, portable information devices, such as an electronic notebook, or a liquid crystal display monitor taking advantage of the description of being a low power, with the thin shape. TN (Twisted Nematic) mode in which a dielectric anisotropy carries out orientation of the forward liquid crystal ingredient horizontally to a substrate, and a liquid crystal molecule takes a distorted orientation condition at 90 degrees between up-and-down substrates is used for many of these liquid crystal displays. Moreover, since high contrast is realizable compared with TN mode, development in the DAP (deformation aryne DOFEIZU) mode to which the dielectric constant anisotropy carried out orientation of the negative liquid crystal ingredient vertically to the substrate is performed briskly.
[0003]
[Problem(s) to be Solved by the Invention] However, when DAP mode impressed an electrical potential difference compared with TN mode, it was easy to generate muscle-like brightness nonuniformity (for a rubbing muscle to be called below) in the direction which performed processing (rubbing processing is called below) which rubs the front face of the orientation film for specifying the direction of orientation of a liquid crystal molecule with cloth, and it had the problem that display grace fell.
[0004] Especially, in the liquid crystal display (Japanese Patent Application No. No. 201176 [nine to] by the applicant for this patent) of the mold both for transparency reflective using DAP mode, there was a problem that a rubbing muscle was remarkably conspicuous, compared with the transparency mold liquid crystal display using the conventional DAP mode.
[0005] This invention is made in order to solve the above-mentioned technical problem, and it aims at offering the liquid crystal display excellent in display grace that a rubbing muscle is not an eye up.
[0006]
[Means for Solving the Problem] The liquid crystal display of this invention has the liquid crystal layer which the dielectric constant anisotropy pinched between the 1st and 2nd substrates, and

this 1st substrate and the 2nd substrate becomes from a negative liquid crystal ingredient. These 1st and 2nd substrates It has the 1st and 2nd perpendicular orientation film on the front face by the side of this each liquid crystal layer, and rubbing processing is performed only to this 1st perpendicular orientation film, this 1st substrate has a configuration with few level differences to rubbing processing than this 2nd substrate, and the above-mentioned object is attained by that.

[0007] Said 1st substrate has a light filter layer further, and said 2nd substrate is good also as a configuration which has the picture element electrode connected to the switching element and this switching element for two or more picture element fields of every.

[0008] The liquid crystal display of this invention has the liquid crystal layer which the dielectric constant anisotropy pinched between the 1st and 2nd substrates, and this 1st substrate and the 2nd substrate becomes from a negative liquid crystal ingredient. These 1st and 2nd substrates It is the liquid crystal display which has the 1st and 2nd perpendicular orientation film on the front face by the side of this each liquid crystal layer. Said 2nd substrate For every picture element field, it has a reflector field and a transparency electrode field, and this reflector field is higher than this transparency electrode field, and the level difference is formed in the front face of this 2nd substrate. This 2nd perpendicular orientation film Rubbing is carried out in the direction in which the level difference to rubbing processing serves as min, and this 1st perpendicular orientation film has the configuration by which rubbing processing is not carried out, and the above-mentioned object is attained.

[0009] As for the level difference formed in the front face of said 2nd substrate of said reflector field and said transparency electrode field, it is desirable to consider as the configuration which does not exist to said direction of rubbing.

[0010] Hereafter, an operation is explained.

[0011] In the liquid crystal display of this invention, since it can make to confuse rubbing processing with a level difference into min, the poor display (rubbing muscle) resulting from the unevenness of rubbing processing can be reduced. The outstanding display quality is realizable by applying to the vertical orientation film and the liquid crystal display of the mold both for transparency reflective using the liquid crystal ingredient which has a negative dielectric anisotropy especially. Moreover, display quality can be further improved by considering as the configuration in which the level difference to the direction of rubbing does not exist in a picture element field.

[0012]

[Embodiment of the Invention] Hereafter, the operation gestalt of this invention is explained to an example for the liquid crystal display of the mold both for transparency reflective. The liquid crystal display of the mold both for transparency reflective is a liquid crystal display which combines the function of the transparency mold liquid crystal display displayed using the transmitted light from the back light prepared in the liquid crystal panel tooth back, and the function of the reflective mold liquid crystal display displayed using the ambient light of the front face of a liquid crystal panel (for example, Japanese Patent Application No. No. 201176 [nine to] by the applicant for this patent). Although effectiveness of this invention is large in the liquid crystal display using the vertical orientation film formed in the front face which has a big level difference, and the liquid crystal ingredient which has a negative dielectric anisotropy so that it may explain in full detail below, also when a level difference is small, it is effective, and is not restricted to the following operation gestalt.

[0013] Hereafter, the operation gestalt of this invention is explained, referring to a drawing.

[0014] (Operation gestalt 1) Drawing 1 shows the mold liquid crystal display 100 both for transparency reflective in the operation gestalt 1 of this invention. Drawing 1 (a) is the top view having shown the active-matrix substrate 20 which constitutes a liquid crystal display 100, and drawing 1 (b) shows the fragmentary sectional view of a liquid crystal display 100, and corresponds to the cross section which met the B-B' line of drawing 1 (a). In addition, the sectional view which met the A-A' line of drawing 1 R> 1 (a) is shown in drawing 4 (b) which shows a production process.

[0015] As shown in drawing 1 (b), the liquid crystal display 100 has the active-matrix substrate 20, the opposite substrate (light filter substrate) 60, and the liquid crystal layer 40 pinched among these. The picture element used as the unit of the minimum display of a liquid crystal display 100 has the transparency field specified with the reflective field specified with a reflector 19, and a transparent electrode 18. The thickness of the liquid crystal layer 40 is dr in a reflective field, and serves as dt (dt**2dr) in the transparency field. This is for making almost equal the optical path length of the light (reflected light of a reflective field, and transmitted light of a transparency field) which contributes to a display. What is necessary is just to set up suitably by relation with a display property, although dt=2dr is desirable. what is necessary is at least, just to

come out dt>dr Typically, dt is about 4-6 micrometers, and dr is about 2-3 micrometers. That is, the level difference of about 2-3 micrometers is formed in the picture element field of the active-matrix substrate 20. In addition, what is necessary is just to set the average to dr, when it has irregularity, as the reflector 19 illustrated.

[0016] Thus, in the mold liquid crystal display 100 both for transparency reflective, the field (a reflective field and transparency field) where the thickness of the liquid crystal layer 40 differs is formed. In this example, it has reflector field 20R from which height differs on the liquid crystal side front face of the active-matrix substrate 20, and transparency electrode field 20T. The vertical orientation film (un-illustrating) is formed in the liquid crystal layer 40 side front face of both the substrates 20 and 60. With this operation gestalt, rubbing processing was performed in the direction shown in the vertical orientation film on the active-matrix substrate 20 by the drawing 1 Nakaya mark R1. For example, the vertical orientation film JALS2004 (Japan Synthetic Rubber make) was printed so that thickness might be set to 80nm, and it was calcinated at 180 degrees C for 2 hours. Rubbing processing was performed to this active-matrix substrate 60 using the cloth made from rayon by roller engine-speed 100rpm and feed-rate 1000 mm/min of a substrate.

[0017] The direction of rubbing in the usual liquid crystal display is a direction (it is 45 degrees in include angle to the gate bus line 22 or the source bus line 24.) shown by the arrow head R2 of drawing 1 (a). However, when rubbing processing was performed in the direction of R2, there was much generating of a rubbing muscle, when rubbing processing was performed in the direction of R1 to only the low liquid crystal display of display grace having been obtained, there was little generating of a rubbing muscle, the orientation condition was good, and the liquid crystal display 100 of the outstanding display quality was obtained.

[0018] When rubbing of this is carried out in the direction of R1, although direct this slack level differences are only the sides alpha and beta of the neighborhoods of transparency field 20T in drawing 1 (a), the length of hair of a rubbing cloth to the direction of rubbing When rubbing is carried out in the direction of R2, there are more many level differences which the length of hair of a rubbing cloth will hit the level difference of the sides alpha, beta, gamma, and delta, and hit a rubbing cloth compared with the case where rubbing is carried out in the R1 direction (the side of a level difference is long). Consequently, the length of hair of a rubbing cloth will be confused, uniform rubbing processing becomes difficult, and it becomes the cause of generating of defects, such as a rubbing muscle, as a result. Therefore, dispersion in the pre tilt angle by the level difference can be pressed down to the minimum by carrying out rubbing in the R1 direction parallel to the longitudinal direction of the configuration of the transparency section.

[0019] The orientation of a liquid crystal molecule is determined by the restraining force of the orientation film formed on the substrate, and the interaction between liquid crystal molecules. Although the reorientation of the liquid crystal molecule is changed into a level orientation condition from a vertical orientation condition by impressing an electrical potential difference when a dielectric anisotropy is a negative liquid crystal ingredient, the direction which carries out reorientation, i.e., the direction where a liquid crystal molecule falls, needs to be uniform within a substrate. An orientation defect (following disclination) occurs that the direction where a liquid crystal molecule falls is scattering, and display grace is degraded. Rubbing processing is performed in order to make it a liquid crystal molecule fall in the same direction uniformly. At this time, the orientation of the liquid crystal molecule is changed into the condition of having inclined in the direction which performs rubbing processing from a substrate normal for a while (whenever [this angle-of-inclination] is called a pre tilt angle below). About the mechanism of rubbing, the side chain of the giant molecule which constitutes the orientation film arranges in the direction of rubbing, and, generally the model that a liquid crystal molecule carries out orientation along with a side chain is considered. However, a carbon number is a long-chain alkyl chain of 3-20 pieces in many cases, and the side chain used for the vertical orientation film is not easy to be stabilized in the one direction and to arrange the direction with it. Although the effectiveness of rubbing is also uniform if the substrate of the orientation film, i.e., the front face of a substrate, is flat, if there is a level difference, as a result of the effectiveness of rubbing changing with locations, it is thought that a pre tilt angle does not become uniform, but it becomes a rubbing muscle, and is visible. Therefore, if there are many level differences to rubbing processing when the vertical orientation film and a dielectric constant anisotropy use a negative liquid crystal ingredient especially, it will be easy to generate generating of poor orientation.

[0020] "The level difference to rubbing processing" as used in this description points out the level difference (it is discontinuous) which has the side which is not parallel to the direction of rubbing in

a picture element field, and the amount of a level difference is evaluated in the sum total of the die length of the side. Since a display is not influenced, it is necessary to take into consideration not any level differences other than a picture element field. Moreover, since it is substantially uninfluential to rubbing processing in the difference in the height of a level difference being less than about 1 micrometer, the difference in height should take into consideration only the level difference of about 1 micrometers or more.

[0021] Below, the configuration and its manufacture approach of a liquid crystal display 100 of this invention are explained. On the glass substrate 11 which is an insulating substrate, two or more gate bus lines 22 as the scanning line and the source bus line 24 as a signal line cross by turns, and this type both for transparency reflective of active-matrix substrate 20 is formed. In the field of the shape of a rectangle surrounded by each gate bus line 22 and each source bus line 24, the transparent electrode 18 which consists of an ingredient with high light transmission effectiveness is arranged independently, and the reflector 19 which consists of an ingredient with high light reflex effectiveness, and it form the picture element electrode with these reflectors 19 and a transparent electrode 18.

[0022] The gate electrode 23 installed in the corner in the field where each of this picture element electrode has been arranged toward the picture element electrode from the gate bus line 22 has branched, and the thin film transistor (TFT) 21 is formed in a part for the point of this gate electrode 23 as a switching element. The above-mentioned gate electrode 23 constitutes a part of TFT21. TFT21 is arranged above the above-mentioned gate electrode 23 formed on the glass substrate 11, as shown in drawing 4 (b). The gate electrode 23 is covered with gate-dielectric-film 11a, and on gate-dielectric-film 11a, the laminating of the semi-conductor layer 27 is carried out so that the upper part of the gate electrode 23 may be covered.

[0023] The both ends on this semi-conductor layer 27 are covered, and the contact layers 28 and 28 of a couple are formed.

[0024] It connects with the source electrode 25 electrically, and the source bus line 24 is superimposed on the point of the source electrode 25 formed on the contact layer 28 in the state of an insulation on the gate electrode 23, and constitutes a part of each TFT21. On the gate electrode 23, in the source electrode 25, spacing is vacated, and it superimposes in the state of an insulation in the gate electrode 23, and the drain electrode 26 of TFT21 is formed on the contact layer 28. And this drain electrode 26 is electrically connected to the picture element electrode through substrate electrode 31a.

[0025] At this time, substrate electrode 31a and the gate bus line 24 of the next step form auxiliary capacity by considering as the structure where it laps through gate-dielectric-film 11a. Moreover, it becomes possible to make effect of a process into homogeneity by [in which the concavo-convex section which mentions this substrate electrode 31a later exists] forming in all fields mostly.

[0026] Under the reflector 19 which consists of an ingredient with the high light reflex effectiveness mentioned above on the other hand, heights 14a and heights 14b with low height with the high height formed at random on the glass substrate 11, and the macromolecule resin film 15 formed on these heights 14a and 14b exist.

[0027] This macromolecule resin film 15 top front face is continuously wavelike by the existence of Heights 14a and 14b mentioned above.

[0028] It exists on the heights 14a and 14b mentioned above, and the reflector 19 mentioned above is formed on macromolecule resin film 15 wavelike part which a top front face follows, light reflex effectiveness is high, for example, this reflector 19 is formed of aluminum. In addition, the reflector 19 is electrically connected with the drain electrode 26 through the contact hole 29.

[0029] Moreover, in the liquid crystal display of the mold both for transparency reflective of this invention, the transparent electrode 18 is formed independently [a reflector 19], and this transparent electrode 18 is formed by an ingredient with high light transmission effectiveness, for example, ITO etc., (Indium Tin Oxide). Next, the formation approach of of the reflector 19 and transparent electrode 18 which are the important section of this type both for transparency reflective of active-matrix substrate 20 is explained based on a drawing. Drawing 2 (a), (b), drawing 3 (a) and (b), and drawing 4 R> 4 (a) and (b) are the process sectional views in a part for the A-A line part of the liquid crystal display shown in drawing 1 .

[0030] First, as shown in drawing 2 (a), on the glass substrate 11, two or more gate bus lines 22 (refer to drawing 1) which consist of Cr, Ta, etc., and the gate electrode 23 which branched from this gate bus line 22 are formed.

[0031] And these gates bus line 22 and the gate electrode 23 are covered, gate-dielectric-film 11a which consists of SiNx, SiOx, etc. is formed the whole surface on a glass substrate 11, and the semi-conductor layer 27 which consists of amorphous silicon (a-Si), polycrystalline silicon, CdSe, etc. is formed on upper gate-dielectric-film 11a of the gate electrode 23. And the contact layers 28 and 28 which consist of amorphous silicon

(a-Si) etc. are formed in the both ends of this semi-conductor layer 27.

[0032] On the one side of these contact layers 28 and 28, superposition formation of the source electrode 25 which consists of Ti, Mo, aluminum, etc. is carried out, and superposition formation of the drain electrode 26 which consists of Ti, Mo, aluminum, etc. is carried out like the source electrode 25 on the other side.

[0033] In addition, with this operation gestalt 1, the thing with a thickness [by Corning, Inc. / of #7059] of 1.1mm was used as a glass substrate 11, for example.

[0034] And as shown in drawing 2 (b), substrate electrode 31a was formed in formation and coincidence of this metal layer 31 by the spatter using the metal layer 31 which constitutes the source bus line 24, and this metal layer 31.

[0035] Then, as shown in drawing 3 (a), patterning of the ITO layer 30 which constitutes the source bus line 24 was carried out by the spatter.

[0036] In this operation gestalt 1, the layer which constitutes the source bus line 24 was made into the two-layer structure of the metal layer 31 and the ITO layer 30. Even if a part of metal layer 31 which constitutes the source line 24 has a membranous defect, since the ITO layer 30 connects electrically, there will be an advantage that an open circuit of the source bus line 24 can be lessened in this structure.

[0037] The transparent electrode 18 which constitutes a picture element electrode in formation and coincidence of this ITO layer 30 was formed using this ITO layer 30. A transparent electrode 18 can be simultaneously made from doing in this way at the time of formation of the source bus line 24, and causing the increment in a number of layers is lost.

[0038] Next, as shown in drawing 3 (b), a reflector 19 forms the heights 14a and 14b of the cross-section approximate circle configuration which consists of resist film 12 of a photopolymer and by which angle dropping was carried out in the bottom of the field by which patterning is carried out.

[0039] Here, the formation process of the heights 14a and 14b formed in this reflective section field is briefly explained using drawing 5 (a) - (d).

[0040] First, as shown in drawing 5 (a), the resist film 12 which consists of a photopolymer is formed with a spin coat method on a glass substrate 11 (in practice, as shown in drawing 3 (b), on the glass substrate 11, the metal layer 31 and substrate electrode 31a are already formed.). In addition, with 3000rpm from 500rpm, and this operation gestalt 1, the spin coat of the photopolymer of OFPR-800 which are the ingredient same as resist film 12 as the macromolecule resin film 15 mentioned later was preferably carried out for 30 seconds by 1500rpm, and thickness of the resist film 12 was set to 2.5 micrometers.

[0041] Next, the glass substrate 11 with which this resist film 12 was formed is prebaked for 30 minutes at 90 degrees C.

[0042] Then, as shown in drawing 6 , the photo mask 13 with which two kinds of circular pattern holes 13a and 13b are formed in board 13c is used, and this photo mask 13 is arranged above the resist film 12, as shown in drawing 5 (b), and as the arrow head of drawing shows from the upper part of this photo mask 13, it is exposed.

[0043] In addition, pattern hole 13a to which the photo mask 13 in this operation gestalt 1 carried out the round shape with a diameter of 5 micrometers, and pattern hole 13b which carried out the round shape with a diameter of 3 micrometers are arranged at random, and at least 2 micrometers or more of spacing of the pattern hole which approaches mutually are isolated. However, if it isolates too much not much, the macromolecule resin film 15 top front face cannot become continuously wavelike easily.

[0044] next -- for example, -- Tokyo -- adaptation -- make -- NMD - three -- from -- becoming -- concentration -- 2.38 -- % -- a developer -- using it -- development -- carrying out -- thereby -- drawing 5 -- (-- c --) -- being shown -- as -- a glass substrate -- 11 -- one side -- an echo -- the section -- a field -- a front face -- height -- differing -- being detailed -- heights -- 14 -- a -- ' -- 14 -- b -- ' -- a large number -- forming -- having . With these heights 14a' and this operation gestalt 1 with which, as for 14b', the upper limb is square, with a height of 1.64 micrometers heights 14b was formed of with a diameter of 5 micrometers pattern hole 13a by pattern hole 13b with a height of 2.48 micrometers heights 14a is formed, and is [b] the diameter of 3 micrometers.

[0045] As for the height of 14b', it is possible these heights 14a' and to make it change with the magnitude of the pattern holes 13a and 13b, the exposure time, and developing time, and it is not limited to above-mentioned size as magnitude of the pattern holes 13a and 13b.

[0046] Next, as shown in drawing 5 (d), it heat-treats by heating heights 14a' and the glass substrate 11 in which 14b' was formed, at 200 degrees C for 1 hour. this -- drawing 5 -- (-- c --) -- having been shown -- as -- an upper bed -- the section -- a corner -- having -- developing negatives -- having had -- as -- heights -- 14 -- a -- ' -- 14 -- b -- ' -- softening -- making -- a corner -- round -- having become -- that is, -- an angle -- dropping -- carrying out -- having had -- a cross section -- an approximate circle -- a configuration -- heights -- 14 -- a -- 14 -- b -- forming .

[0047] The heights 14a and 14b as shown in drawing 3 (b) are formed of a process which was mentioned above. Next, as shown in drawing 4 (a), the spin coat of the macromolecule resin film was carried out on the glass substrate 11, pattern NINGU was carried out and the macromolecule resin film 15 was formed. OFPR-800 mentioned above were used as a macromolecule insulator layer, and the spin coat was carried out by 2000rpm with this operation gestalt 1 which carries out a spin coat by 1000rpm - 3000rpm preferably.

[0048] The macromolecule resin film 15 which carried out the shape of a wave which a top front face follows by this will be formed.

[0049] Next, as shown in drawing 4 (b), the reflector 19 which consists of aluminum was formed in the predetermined part on the macromolecule resin film 15 mentioned above by carrying out sputtering, for example. As an ingredient suitable for using it for a reflector 19, Ta, nickel, Cr, Ag, etc. for example, with high light reflex effectiveness can be mentioned other than aluminum or aluminum alloy, and about 0.01-1.0 micrometers is suitable as thickness of a reflector 19. Thus, the reflector 19 which consists of an ingredient with the formed high light reflex effectiveness becomes continuously wavelike [a top front face] like the substrate film.

[0050] In this operation gestalt 1, although the transparent electrode 18 is formed in formation and coincidence of the source bus line 24, when the source bus line 24 is not the two-layer structure of the metal layer 31 and the ITO layer 30 but the monolayer of the metal layer 31, formation of a transparent electrode 18 and formation of the source bus line 24 may be separate.

[0051] In addition, although [the configuration of the pattern holes 13a and 13b of a photo mask 13 / this operation gestalt 1] it is circular, other forms are sufficient as this, for example, a rectangle, an ellipse, SUTORAIBU, etc. may be the configurations of arbitration.

[0052] Moreover, although the heights 14a and 14b from which two height differs are formed with the above-mentioned operation gestalt 1, even if not only this but heights form the heights of three or more different height for at least three height in this invention again, it is possible to form the reflector which has a good reflection property.

[0053] However, it turns out a reflector with the more good wavelength dependency of a reflection property is obtained rather than the way which formed heights by the heights from which two or more height differs forms in one height.

[0054] Here, only by forming Heights 14a and 14b, as long as it seems that the shape top front face of a continuous wave is obtained, the shape top front face of a wave which follows formation **** only by the resist film 12 in the giant-molecule resin film 15 may be formed, and a reflector 19 may be formed. By carrying out like this, it becomes possible to shorten the process which forms the macromolecule resin film 15. moreover -- the above-mentioned operation gestalt 1 -- as a photopolymer ingredient -- Tokyo -- adaptation -- although shrine 800 [OFPR-] are used, this invention is not restricted to this and should just be the photopolymer ingredient which can carry out pattern NINGU using an exposure process irrespective of a negative mold and a positive type. for example, Tokyo -- adaptation -- shrine 83 [OMR-] and OMR- 85, ONNR-20, OFPR-2, OFPR-830, OFPR-500, etc. -- you may be -- being certain -- it is -- you may be TF-20 made from Shipley, 1300-27, or 1400-27. Furthermore, you may be photograph NISU by Toray Industries, Inc., RW-101 by the Sekisui fine chemical company, R101, R633 by Nippon Kayaku Co., Ltd., etc.

[0055] With the above-mentioned operation gestalt 1, although TFT21 is used as a switching element, this invention is applicable not only to this but the active-matrix substrate using other switching elements, for example, an MIM (Metal-Insulater-Metal) component, diode, a varistor, etc.

[0056] The configuration of transparency section 20T is not restricted to the above-mentioned example. For example, as typically shown in drawing 7 (a) and 7 (b), transparency field 20T' may be formed so that it may pierce through two or more picture element fields. Drawing 7 (b) is the sectional view which met the C-C' line of drawing 7 (a). Since the transparency field exists in the above-mentioned example (drawing 1) in the form which hollowed some reflectors, If transparency field 20T' is formed in the appearance shown in drawing 7 (a) to the level difference which a rubbing cloth senses to the direction of rubbing not having been lost thoroughly Since the level difference which a rubbing cloth senses to the direction of rubbing in a picture element field does not exist, turbulence of the length of hair of the rubbing cloth by the level difference is lost by this, and uniform rubbing can be realized. Consequently, the liquid crystal display of the outstanding display quality is obtained.

[0057] (Operation gestalt 2) With this operation gestalt 2, vertical orientation film (un-illustrating) rubbing processing on the light filter substrate 60 of the liquid crystal display 100 shown in drawing 1 is performed, and the example which does not perform rubbing processing is explained to the vertical orientation film on the active-matrix

substrate 20.

[0058] Drawing 8 is the top view of the light filter substrate 60 which is an opposite substrate, and the sectional view of the line by which drawing 9 (a) met the D-D' line of drawing 8 , and drawing 9 (b) are the sectional views which met the E-E' line of drawing 8 . The light filter layers 64R, 64G, and 64B which consist of red, green, and blue are formed by the thickness of about 1.2 micrometers on the glass substrate 62, and the ITO film 66 which is a transparent electrode is formed on it. Between these light filter layers, the protection-from-light layer 67 which consists of Cr is formed.

[0059] On the above-mentioned active-matrix substrate 20 and the light filter substrate 60, the vertical orientation film JALS2004 (Japan Synthetic Rubber make) was printed so that thickness might be set to 80nm, and it calcinated at 180 degrees C for 2 hours. Rubbing processing was performed to this opposite substrate using the cloth made from rayon by roller engine-speed 100rpm and feed-rate 1000 mm/min of a substrate. At this time, the direction of rubbing was performed in the direction (the direction of Y) parallel to the D-D' line of drawing 8 . Rubbing processing was not performed about a active-matrix substrate. The lamination liquid crystal panel was produced for the active-matrix substrate 20 and the opposite substrate 60 which were produced like the operation gestalt 1 with the epoxy resin through the 3-micrometer spacer. The dielectric anisotropy poured the negative liquid crystal ingredient (MJ: Merck Co. make) into this panel, the polarizing plate and the phase contrast plate were arranged, and the liquid crystal display of the mold both for transparency reflective was completed. The opposite substrate 60 can be formed by the well-known approach. Although the level difference according [the front face of the opposite substrate 60] to the light filter layer 64 exists, the level difference does not exist to rubbing processing of the direction of Y. Therefore, the direction of D-D' has a very small level difference compared with the direction of E-E', or the active-matrix substrate 20 so that clearly from drawing, and uniform orientation restraining force can be given to the liquid crystal layer 40 by carrying out rubbing processing in the direction of D-D' at parallel. A rubbing muscle is reduced substantially, without generating disclination, without carrying out rubbing processing of the opposite substrate 60 which was able to give this uniform orientation restraining force, and the active-matrix substrate 20 in which many level differences exist by the interaction between liquid crystal molecules, since the direction where a liquid crystal molecule falls is regulated in an one direction.

[0060] (Operation gestalt 3) The above-mentioned operation gestalt 1 constitutes a reflector field from this operation gestalt to having formed the reflector field with the electrode which has a reflection property using a reflecting layer (reflecting plate) and a transparent electrode. A reflector field points out the field on the substrate equipped with the reflex function and the function to impress an electrical potential difference to a liquid crystal layer. In the operation gestalt 1, although the reflector which has irregularity was formed in the front face, the need does not not necessarily exist.

[0061] Drawing 10 (a) shows the sectional view where (b) met the F-F' line of (a) in the plan of the active-matrix substrate 80 used for the liquid crystal display of this operation gestalt. If the active-matrix substrate 80 is observed from the upper part as shown in drawing 10 (a), transparency electrode field 80T are prepared in the center section in a picture element at a square, and reflector field 80R is prepared so that it may be enclosed. The outline of reflector field 80R serves as a square along the edge of the gate wiring 82 and source wiring 84. In this example, the layer 89 (reflecting layer) with the high reflection factor formed with the same ingredient as the gate electrode 83 (and gate wiring 82) is formed in reflector field 80T.

[0062] As shown in drawing 10 (b), the reflecting layer 89 is covered with gate dielectric film 92, and the transparent electrode 88 which functions as a picture element electrode is formed on it. The reflecting layer 89 and the transparent electrode 88 are insulated. The transparent electrode 88 formed on the reflecting layer 89 and the reflecting layer 89 forms reflector field 80R.

[0063] The active-matrix substrate 80 deposits the electric conduction film which consists of a reflexible ingredient on the insulating substrates 81, such as a glass substrate, and forms the gate electrode 83, the gate wiring 82, and a reflecting layer 89 by carrying out patterning of this electric conduction film. It deposits, patterning of the n+-Si layer 95 which serves as the semi-conductor layer 93 after forming wrap gate dielectric film 92, the channel protective layer 94, and a source drain electrode in the gate electrode 83, the gate wiring 82, and a reflecting layer 89 is carried out at order, and TFT81 is formed. Metal layer 97b which becomes some source wiring 84, and the drain-picture element electrode connection layer 96 are formed in the same process. The connection layer 96 is superimposed on the drain electrode 95 of TFT81 in part, and is electrically connected to it. Patterning of the transparence electrical conducting material (for example, ITO) is formed

and carried out by the spatter, and upper 97a of a transparent electrode 88 and source wiring 84 is formed. A transparent electrode 88 is formed throughout the inside of each picture element, and functions as a picture element electrode. The transparent electrode 88 is electrically connected to the drain electrode 95 of TFT81 by superimposing a part on the connection layer 96. Then, the wrap passivation membrane 98 is formed in TFT81 at least.

[0064] As the wrap vertical orientation film (un-illustrating) is formed and these were mentioned above, a active-matrix substrate with little generating of a rubbing muscle is formed in the direction (it is parallel to the long side which is transparency electrode field 80T) with few level differences to rubbing processing by performing rubbing processing [in a picture element field]. The height of reflector field 80R is controllable by the thickness of a reflecting layer 89, and preparing and adjusting a passivation membrane 98 in a reflector field.

[0065]

[Effect of the Invention] As explained in full detail above, according to this invention, the poor orientation by rubbing processing does not occur, but the liquid crystal display which was excellent in display quality is offered. The outstanding display quality is realizable by applying to the vertical orientation film and the liquid crystal display of the mold both for transparency reflective using the liquid crystal ingredient which has a negative dielectric anisotropy especially.

[Brief Description of the Drawings]

[Drawing 1] The mold liquid crystal display 100 both for transparency reflective in the operation gestalt 1 is shown. (a) is the top view showing the active-matrix substrate 20 which constitutes a liquid crystal display 100, and (b) is the fragmentary sectional view of a liquid crystal display 100.

[Drawing 2] It is a sectional view explaining the production process of the active-matrix substrate 20.

[Drawing 3] It is a sectional view explaining other production processes of the active-matrix substrate 20.

[Drawing 4] It is a sectional view explaining other production processes of the active-matrix substrate 20.

[Drawing 5] It is a sectional view explaining the formation approach of the heights formed in the reflective section field of the active-matrix substrate 20.

[Drawing 6] It is the top view in which using for in order to form heights in a reflective section field, and showing a **** photo mask.

[Drawing 7] It is the top view showing other active-matrix substrates used for the liquid crystal display of this invention, and (b) is the sectional view which met the C-C' line of (a).

[Drawing 8] It is the top view of the light filter substrate 60.

[Drawing 9] (a) is the sectional view which met the D-D' line of drawing 8 , and (b) is the sectional view which met the E-E' line of drawing 8 .

[Drawing 10] It is the top view showing other active-matrix substrates used for the liquid crystal display of this invention, and (b) is the sectional view which met the F-F' line of (a).

[Description of Notations]

18 66 Transparent electrode
19 Reflector
20 Active-Matrix Substrate
20R Reflector field
20T Transparency electrode field
40 Liquid Crystal Layer
60 Opposite Substrate (Light Filter Substrate)
100 Liquid Crystal Display